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DRAWINGS ATTACHED.

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COMPLETE SPECIFICATION.

Fluidizing Unit.

I, HAMILTON NEIL KING PATON, a Canadian Citizen, of 4279 Pelly Road, North Vancouver, British Columbia, Canada, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a fluidizing unit which may be built into or placed in compartments, bags, conduits and the like, on which materials in small particle form are moved in a fluid-like state, and to a method of fluidizing such materials in said compartments, bags, conduits and the like. Examples of the small particle material to be handled are flour, sugar, cement, wheat, and the like.

Many attempts have been made to fluidize material in small particle form in conduits so that said material may be moved along the conduit in a fluid-like state. However, such conduits had to have plenum chambers under the surfaces and co-extensive therewith over which the particle material travelled. Materials of very close weave, such as canvas, have been used to form the conduit surface over which the materials travelled, air being blown from the plenum chamber through the fabric to fluidize the material on the latter. The fabric had to be stretched across the conduit spaced from the bottom thereof in order to support the load of the material. This limited the amount of the load in the conduit, and it limited the width of such a conduit since the fabric could not be stretched tight enough to carry in a practical manner a load extending over a comparatively great width. This difficulty also made it impractical to use such stretched fabric in large bins or compartments in which the particle materials were stored in depth and moved only during the unloading operation, unless the bottoms thereof were inclined fairly steeply to comparatively narrow fluidizing sections which, in effect, were centrally-located conduits.

Porous stone-like blocks have been used in conduits. However, these required plenum chambers under the blocks, thereby wasting space, and limiting the size of the conduit since the blocks could not support a very great load without having a complex and expensive supporting structure associated with them. Also, these blocks were fragile and therefore limited in size to comparatively small area blocks.

In attempts to unload comparatively large bins by a fluidizing operation, collapsible mats having one or more plenum chambers therein are used. In its very simplest form, the mat consists of a tube formed of a closely-woven fabric. Such a tube is used only in very narrow troughs. The difficulty with tubes of this nature is that when air or gas is blown into them under pressure, they assume a substantially circular cross-sectional shape. This means that any material on the upper surface thereof is directed laterally and is trapped in the trough between the tube and the sides of the latter. For relatively wide areas, mats substantially in the form of several tubes or channels longitudinally sewn together are used. The mats formed by the tubes or channels are normally collapsed under the load, but when air under pressure is directed into the mat tubes, the particle material next to the surfaces thereof is fluidized. However, as the load on the mat lessens, the individual tubes assume a substantially circular cross-sectional shape. The tube idea has to be used in order to keep the upper surface of the mat from billowing upwardly from side

to side of the container and to reduce tension on the seams of the mat to a practical point. As the tubes of the mat are secured together longitudinally thereof, there is a large percentage of the surface having no air passing through it along these seams, and the blown up tubes of the mat direct material into these blind strips or troughs where it has a tendency to remain. Another disadvantage of the tubular mat idea is that when the tubes are formed, the edges of the mat move inwardly thereof. This effect is lessened to some extent by anchoring the mat edges in place, but the tubes have to be made very narrow in order to prevent undue strain on the stitching therebetween.

The main object of the present invention is the provision of a fluidizing unit which eliminates the necessity of a plenum chamber beneath the particle bearing surface thereof.

Another object is the provision of a fluidizing unit which may be used as part of large or small floors and which is so constructed that the upper or particle bearing surface thereof remains substantially even regardless of whether the mat is under heavy or light load.

Another object is the provision of a fluidizing unit which may be made conveniently in continuous strips and cut into desired lengths, sizes and shapes for any particular job.

A further object is the provision of a unit of the nature described which has very little surface tension and does not tend to draw inwardly at the edges thereof so that peripheral tension is eliminated.

Yet another object is the provision of a method of unloading small particle material by fluidizing means without completely fluidizing the material under load.

A still further object is the provision of a fluidizing unit including means for distributing gas evenly throughout the unit to provide a uniform flow of gas through the entire surface thereof.

Still another object is the provision of a flexible fluidizing unit for collapsible bags, whereby the bags may be folded and rolled into comparatively small bundles when they are not required.

Another object is the provision of a fluidizing unit which makes it possible to fluidize material over the entire area of a relatively large compartment without the necessity of sloping walls.

This fluidizing unit is preferably laid over a support, such as a floor or wall, or over the bottom of a collapsible bag. The unit may be permanently or removably mounted on its support. However, it will be understood that the unit may be built into or as part of the floor, wall or bag bottom.

One form of fluidizing unit according to the present invention comprises a body formed of a material having minute interconnected cells therethrough and opening outwardly from the surface thereof over which material in small particle form is to be moved. This body may be formed of porous stone-like material which is well known in the field, but it is preferable to make it from a flexible or semi-rigid interconnected cellular material. A distributing network of small closely arranged channels extend throughout the body spaced inwardly from the face surface thereof and substantially parallel to the latter, said minute cells communicating with the channels. The channels are preferably interconnected, but they may be separated from each other, if desired. Means is provided for directing gas under pressure into these channels. The unit body is such that the face surface remains substantially even under both heavy and light loads and when gas under pressure is being directed along the channels and thence through the minute cells to and through the face surface. Furthermore, the cells in the body are such as to distribute the gas evenly throughout the face surface to fluidize any particle material on said surface.

Although it is preferable to form the unit body of a single thickness of material, it is to be understood that it may be formed of two superimposed layers of different material. In this case, the upper layer is formed of material having minute interconnected cells therethrough, while the lower layer is formed of any suitable material and has the channel network formed in its upper surface. The layers may be held together in any convenient manner, such as by gluing or a suitable frame around the edges thereof. Actually, the unit body formed of the same material throughout may be considered two layers, the upper part acting as a diffusing layer and the lower part as a body for the channel network. For convenience in manufacture, the body may be formed in two pieces of similar material secured together at the channel network. Furthermore, the lower layer of the unit may actually be part of the floor or bottom of the structure in which the unit is located.

A fluidizing unit of this type is usually laid on the floor or bottom of a compartment, bag, conduit or the like along which materials in small particle form are to be moved in a fluid-like state. The edges of the unit may be sealed against the confining walls of the compartment, bag, conduit or the like, in any suitable manner, such as by the use of plastic sealing compounds or adhesives, in order to keep the materials from getting under the unit.

It has been found desirable to provide means in the body to create a controlled resistance to the flow of gas therethrough.

This may be in the composition of the cellular material above the channel network or in the form of a layer of fabric of close weave over the face surface of the body or incorporated in the latter spaced below said surface, or it may be a so placed layer of other suitable material for this purpose. If the cells of the body are closed under load, the created resistance to the flow of gas produces a back pressure in the cellular body which tends to open up or re-expand the cells thereof. The bottom and edges of the unit body may be sealed in any suitable manner in order to prevent gas from passing therethrough, although the confining walls and bottom of the compartment or conduit may serve this purpose.

In the well known prior art consisting of stretched flexible air-pervious materials, when used in storage and transportation structures of a width greater than approximately 14 inches, it is absolutely essential to construct the bottom in the form of one or more elongated fluidizing conveyors and with one or more sides which slope upwardly and outwardly from said conveyors. These sloping walls combined with the necessary plenum chambers below each fluidizing conveyor result in a major loss of storage space and also result in a very costly structure. The fluidizing unit of the present invention eliminates the cost of storage space wasted in the above construction as it requires neither sloped walls above nor plenum chambers below the fluidizing unit.

As previously stated, the fluidizing body may be formed of any material having the required degree of porosity or minute interconnected cells opening outwardly from the face surface throughout the entire area thereof. A suitable porous stone-like material of the type well known in this art may be used, or a suitable flexible or semi-rigid interconnected cellular material may be used, such as polyurethane foam, e.g., polyester foam or polyether foam; cellulose foam, natural and synthetic rubber foam, or the like. If a fabric layer is used, it may be made of any suitable material, such as a canvas or fabric of close weave. There may be one or more layers of this fabric in or on the surface of the cellular body. A layer of gas-impervious material may be bonded on to the under or bottom surface of the body, or said surface may be sealed off by a suitable impermeable adhesive or plastic material. The edges of the body may be closed or sealed off in the same manner. A suitable header may be provided along one or more edges of the unit body into which the channels of the distributing network open. In this case, the gas, such as air, is pumped into the header or headers for distribution throughout the unit along the channels. This gas, being under pressure, diffuses from the channels through the entire body outwardly of the channels because of the minute interconnected cells formed in said body.

While the fluidizing unit is usually located on the bottom of a container or trough, it may be on an inclined surface or a vertical wall or partition for fluidizing purposes.

When gas is being directed throughout the entire channel network of a fluidizing unit, there are pressure losses that have to be taken into consideration if fluidization is to be even over the whole surface of the unit. In view of this, it has been found desirable for comparatively large units to form the unit body of a rigid or a semi-rigid material. In this case the channel network is arranged so as to maintain a uniform pressure throughout the network to obtain an equal rate of gas flow through the interconnected cells over the entire body surface. This is usually accomplished by diminishing the area of the channel network from one end of said network towards the other.

Examples of this invention are illustrated in the accompanying drawings, in which:—

Figure 1 is a diagrammatic perspective view of a storage compartment with the walls thereof broken away in order to show a fluidizing unit therein;

Figure 2 is a horizontal section through the compartment looking down on the unit;

Figure 3 is an enlarged cross-section through the compartment taken on the line 3—3 of Figure 2 and through one form of fluidizing unit;

Figure 4 is a very much enlarged horizontal section through a portion of the unit and taken on the line 4—4 of Figure 3;

Figure 5 is a perspective view of a portion of one end of the unit alone;

Figure 6 is an enlarged cross-section through an alternative form of unit;

Figure 7 is a view similar to Figure 6 through still another alternative form of unit;

Figure 8 is a horizontal section through a circular or silo-type of storage compartment, illustrating a form of fluidizing unit particularly adapted for this type of compartment;

Figure 9 is an enlarged section taken on the line 9—9 of Figure 8;

Figure 10 is a perspective view of a tubular conduit with a fluidizing unit therein;

Figure 11 is an enlarged longitudinal section through the conduit taken on the line 11—11 of Figure 10;

Figure 12 is a diagram illustrating the diffusion of the gas in the fluidizing unit;

Figure 13 is a plan view of another alternative form of fluidizing unit for a rectangular compartment having a central discharge outlet;

Figure 14 is a plan view of yet another alternative form of fluidizing unit for a compartment having a discharge outlet in a wall thereof; and

Figure 15 is a reduced perspective view of a compartment in the form of a collapsible bag incorporating a fluidizing unit therein.

It will be realized that this fluidizing unit is very thin compared to the size of the compartment, bag or conduit in which it is located and, therefore, the drawings are out of proportion and merely serve to illustrate the unit and its location in the compartment, bag or conduit.

Referring to Figure 1 of the drawings, 10 is a storage compartment having side walls 11 and 12, end walls 13 and 14, and a bottom or floor 15. This floor may be sloped or horizontal. The compartment has a discharge outlet 18 near the bottom or floor thereof. In this example, the discharge outlet is in end wall 14, but it may be in any other wall, or it may be in the bottom itself.

A fluidizing unit 22 is spread over the bottom or floor of compartment 10 and extends between the confining walls of the latter. This unit may be freely laid over the compartment floor, or it may be secured thereto by a suitable adhesive, and/or the unit edges may be sealed to the adjacent compartment walls by a suitable adhesive or in any other manner in order to keep material from getting between the unit and the compartment walls and floor.

Figures 3 and 4 show fluidizing unit 22 in detail. This unit comprises a body 25 formed of porous stone-like material or, as preferred, of a flexible or semi-rigid material as hereinbefore stated. The unit body is formed of a material having minute interconnected cells therethrough and opening outwardly from a face thereof, as generally indicated by the numeral 27. These cells are extremely small, but they are distributed evenly throughout the material and open out through the entire upper or face surface 28 thereof.

A distributing network of small closely arranged channels 30 extends throughout the body 25 spaced inwardly from the surface 28 thereof so that there is a thickness of the body material between the channels and the surface for diffusing purposes, as indicated at 32. This thickness 32 also helps to keep channels 30 open when the unit is under load. There are a great many of these channels extending longitudinally and/or transversely throughout the unit body in a substantially common plane. If there are both longitudinal and transverse channels, as shown, they may be interconnected with each other, as shown in Figure 4. There may, however, be several networks of these channels at different levels throughout the body. These channels may extend to and open outwardly through the edges of the unit, as shown, or they may terminate inwardly from one or more of said edges. Furthermore, although the channels have been shown as being arranged in a regular pattern, it is to be understood that they may be irregularly arranged or comprise a series of comparatively large interconnected cells. Therefore "interconnected channels" include any system for distributing gas throughout the unit body.

When the unit 22 is placed in the compartment 10 over the floor 15 thereof, the edges of the unit extend to the confining walls of the compartment. These walls close the edges of the unit body, and the compartment floor closes the lower or under surface of the unit, although the unit may be glued to the floor and confining walls, in which case the glue seals the bottom and edges of the body, it is preferable freely to lay it in the compartment. In the latter case, the bottom and any exposed edges of the body should be sealed in any suitable manner. Instead of gluing, the mat edges may be secured to the compartment walls in any desired manner.

It is preferable to arrange the network of channels 30 so as to maintain throughout said network a uniform pressure of the gas supplied thereto as hereinafter explained. In this example, this is accomplished by forming the unit in two mating triangular sections 33 and 34. These sections are provided with adjacent sealed sides indicated at 35. The sealed sides separate the channel networks 30 of the two sections. The sides may be sealed and secured to each other by a suitable adhesive, or they may be sealed by some gas-impervious material.

Suitable means is provided for directing gas, such as air, under pressure into the distributing network of the channels. This may be done from the top, bottom or one or more edges of the unit. In this example, a header 36 is secured to and extends across an end edge and a side edge of the unit. The channels opening out through said edges communicate with the interior of the header. Gas is supplied to the header in any suitable manner, such as by means of a pipe 37 which extends outwardly therefrom and out through a wall of the compartment. While a header common to a unit end and side has been shown, it is to be understood that two separate headers may be used, in which case there would be a pipe 37 for each header.

The compartment 10 has a filler opening, not shown, near the top thereof for any material in small particle form, such as flour, sugar, cement, wheat and the like. The particle material is supported by unit 22. The construction of the unit is such that it does not compress very much, if at all, under the load. However, it does not matter whether it does compress if it is formed from a foam material, since it resumes its normal shape

and size as the load lessens. It usually is preferred to form the unit body of a rigid or semi-rigid material that will not collapse under load.

If desired, outlet 18 may be located in compartment wall 13 near pipe 37. In this case, the gas is directed into the unit body near said discharge outlet. With this arrangement, when the discharge outlet is first opened, the material in the compartment flows under gravity through said outlet. This lightens the load near the outlet so that there is no difficulty in getting gas into the unit body near said outlet. The gas from pipe 37 is directed into the network channels by header 36. The gas enters the channels and diffuses upwardly through the minute cells of the unit body and passes through the surface 28 of the unit near the discharge outlet, the weight of the particle material on the unit preventing the escape of gas through the remainder of the surface. This fluidizes the material on the body near the outlet so that it continues to run out of the latter. The area of fluidization gradually increases as the load continues to flow through the outlet.

As stated above, the discharge outlet 18 is preferably remote from the air inlet pipe 37 and the unit preferably formed of a rigid or semi-rigid material. Header 36 directs the gas into the channel networks 30 of both unit sections 33 and 34. As some of the particle material runs out of outlet 18 when the latter is opened, fluidization starts adjacent said outlet, the load of particle material on the remainder of the unit preventing the flow of gas through said remainder. The area of fluidization gradually increases as the fluidized material runs out of the outlet. As the area of each channel network diminishes in a direction away from the header of its unit section, the pressure of the air is uniform throughout each section. Thus, when the load is comparatively light over the unit surface, there is a uniform flow of air through the entire surface. In other words, it is not necessary to provide excessive gas pressure at the gas inlet in order to provide a minimum of pressure at the farthest point from said inlet.

One of the main advantages of a compressible fluidizing unit is that when the load on it lessens, it returns to its normal state so that surface 28 remains even. There are no blind spots in the surface since the minute cells are distributed throughout the material of the unit body, and there are no troughs formed in said surface in which material may be trapped as the unloading continues. As the unit surface stays substantially flat, the edges of the unit do not move inwardly as the load lessens. Furthermore, the surface does not have to be maintained under tension.

As previously stated, the unit may be placed on a horizontal or an inclined floor. The floor may be such that it can be moved to an inclined position when it is desired to remove the last part of a load from the compartment. For example, if the compartment is a vehicle, the latter may be tipped to cause the unit to slope towards the discharge, or the floor may be raised to an incline by mechanical, pneumatic or hydraulic means. Channels 30 may be formed in any convenient manner. One way is to mould the upper and lower horizontal halves or layers of the unit body separately with channels formed in one face surface of either or both halves. The two halves or layers are then secured together by means of a suitable adhesive with the channels spaced from the upper surface of the unit. If channels are formed in both halves or layers, it is preferable that they may be mated when the halves or layers are put together. Furthermore, the channels may actually be formed in the floor or bottom of the compartment and a layer of the cellular material secured in place over these channels, said channels communicating with the cells of the material. In the latter example, the fluidizing unit is partly built into the floor of the compartment.

Figure 6 illustrates an alternative form of fluidizing unit. The unit 40 is formed of a suitable material having minute interconnected cells therethrough and opening outwardly through face 41. A distributing network of small closely arranged channels 43 is provided in the unit spaced from and extending substantially parallel to surface 41. This unit has a layer of fabric 45 of fairly close weave secured to surface 41 in any desired manner, such as by foaming the material directly thereon or by an adhesive. In the latter case, the adhesive may be applied to the material of the unit only and not in the small cells at the face surface. The lower surface 48 of the unit body is sealed off by means of a layer 49 of gas-impervious material, such as rubberized canvas. However, the surface may be sealed off by a layer of adhesive that fills the cells at said surface. Similarly, the edges of the unit are sealed off by strips of gas-impervious material 50 secured thereto in any convenient manner, such as by adhesive, or the adhesive itself may constitute the sealing means.

Although the fabric layer 45 has been shown on the face surface of the unit, it may be incorporated in the unit body spaced a little from and extending substantially parallel to said surface.

Unit 40 functions in the same manner as the above-described unit. The fabric layer 41 helps to create a back pressure in the cellular body which tends to open up or re-expand the cells thereof if they are compressed under a load.

Figure 7 illustrates a fluidizing unit 55

which is similar to unit 40. However, in this case, the cellular unit body 56 has a distributing network of small closely arranged channels 57 in its lower surface 58. These channels may be closed on the outer surface of the unit by a layer of gas-impervious material 60. However, the latter layer may be omitted since the unit is laid on the floor, and the floor acts as a wall for the channels. In the latter case, it is preferable to secure the unit to the floor by means of a suitable adhesive.

Figures 8 and 9 illustrate a silo-like storage compartment 65 having a bottom or floor 66. This floor slopes inwardly as indicated at 67 to a central discharge outlet 68, although the slope may be omitted. A fluidizing unit 70 of any of the above-described constructions is placed over this floor, and may be secured thereto in any suitable manner, such as by means of an adhesive, although this is not absolutely necessary. The unit has a central discharge opening 71 therein registering with the outlet 68 of the compartment. This unit has the usual network of channels, and air is supplied to these channels in any desired manner. For example, a header 74 may be provided around the unit periphery, and one or more pipes 73 is or are connected to this header to supply gas thereto, said pipe or pipes extending out through the wall of the compartment, as shown. It is preferable to divide the unit into a plurality of sections or segments 76. Each unit is sealed along its edges 77 and the units are secured together in any convenient manner, such as by an adhesive. With this arrangement, the area of the channel network of each section diminishes from the air inlet or header 74 towards the outlet 68 of storage compartment 65. Thus, a uniform pressure is maintained in the gas in the network.

Unit 70 functions in the same manner as the other units. Figures 8 and 9 merely illustrate another way in which fluidizing units of this invention may be used.

As previously stated, the fluidizing unit may be used in conduits. If conduits of rectangular cross-section are used, it is only a question of making the unit longer and narrower than for the compartments described above. Furthermore, the unit may be made in sections for either conduits or compartments, in which case, the unit sections are secured edge to edge by suitable adhesive, the channels of each section may or may not communicate with the channels of each abutting section. If not, gas is supplied by a pipe to each section.

Another advantage of this idea is that where sections are joined there is practically no loss of fluidizing area, but in the prior art, ends of fabric are screwed or bolted down to suitable connections and supports to prevent air loss, thereby creating unfluidized surface areas which act as a deterrent to maximum flow.

A further advantage of this fluidizing unit is that it may be used in compartments or conduits of cross-sections other than rectangular since the face surface of the unit cannot billow outwardly under the pressure of the fluidizing gas. Figures 10 and 11 illustrate how this is done in a conduit of circular cross-section.

A conduit 80 in the form of a pipe has a fluidizing unit 81 of any of the above-described formations lying therein. The unit preferably extends across the bottom and part way up the side walls of the surface of the pipe that constitutes the conveying surface thereof. Gas is supplied to the channel network 82 of the unit at one or more points in any desired manner. Figure 11 shows gas inlet pipes 84 and 85 extending through the bottom of the conduit with headers 86 and 87 incorporated in the unit. These headers are merely enlarged channels formed in the unit body.

Unit 81 fluidizes particle material on the face surface thereof in the same manner as the previously-described units. Advantages of this unit as over the tube-type of unit mentioned above or the laterally-stretched conveying fabric of the prior art conduits are that it may be used in circular pipes, it directs the fluidizing gas towards the longitudinal centre of the pipe, it fluidizes across the bottom and part way up the sides of the conduit, and it eliminates the necessity of a plenum chamber beneath the conveying surface so that practically the entire conduit is available for the material to be conveyed.

As indicated, it is preferable to use a suitable flexible or semi-rigid interconnected cellular material for this fluidizer unit, such as an artificial plastic or rubber sponge or foam so long as the cells therein are interconnected. Besides the advantages pointed out above, there is the additional advantage that this material may be foamed directly on a gas-impervious material which is to form the bottom and, if desired, the edges of the unit with or without a header incorporated in it, and with or without the close weave fabric incorporated at or below the surface of the unit body.

The use of a flexible, rigid, or semi-rigid material to form this fluidizing unit has the further advantage that the material may be made in continuous strips and then cut to desired sizes for the compartments or conduits. Once a unit is cut from the material, its edges may be sealed as desired. If fabric is secured to the top and bottom surfaces of the unit, it still may be made in an endless piece and said fabric secured thereto as an endless piece, in which case the unit may be cut to desired sizes.

Figure 12 diagrammatically illustrates the manner in which the gas is diffused by the cellular material comprising at least the outer portion of the unit body. Unit 22 has been used as an illustration. The gas, usually air, in the channels 30 is under pressure which exerts an equal force in all directions. Thus, the gas tends to move out of the channels in radial directions as indicated by arrows 90. This gas also has a tendency to move upwardly and to expand. Therefore, the cellular material diffuses the gas laterally as it moves upwardly to the surface thereof, as indicated by arrows 92. The channels are placed so close together that there is an overlap of the gas from adjacent channels as it reaches the unit surface, as indicated at 93.

It is also pointed out that the material of the unit body between adjacent channels forms columns extending from the top to the bottom surfaces of the unit. One such column is indicated at 95 in Figure 12 between lines 96 and 97. This construction provides in effect continuous support for the load over the entire unit, and the columns help to keep the channels open. This supporting of the load takes place throughout the unit and not from the edges thereof, and it does not require any special supporting mechanism beneath the unit but is inherent in the latter. Furthermore, it does not interfere with but forms part of the gas diffusing means of the unit.

The ultimate goal of every air fluidizing system used for discharging granular products from holding structures is to provide uniform air or gas flow over the entire area into the material being fluidized at all times, while maintaining a completely even fluidizing surface on which the material flows. The present invention accomplishes this in a unique way. With the increased distance from the peripheral gas supply header, the distributing network is preferably reduced in area thus providing substantially uniform pressure throughout the entire fluidizing unit. By creating this uniform pressure the fluidizing gas flow is maintained at a uniform rate over the entire surface.

Figure 13 illustrates a fluidizing unit 102 which is similar to that of Figure 8, the main difference being that it is intended for a rectangular compartment or bin 104. This bin has a discharge outlet 105 located centrally of the bottom thereof. The unit has a central discharge opening 107 registering with the compartment outlet. The unit is constructed as described above, and it is divided into a plurality of sections 110 of triangular shape, said sections being separated by gas-impervious walls 112. Actually the sections may be cut from the desired fluidizing material and then glued together at their adjacent edges 112 with a glue that forms the impervious walls. A gas header 115 is formed completely around unit 102, and at least one gas inlet pipe 118 extends through the compartment wall into this header.

During the unloading of compartment 104, unit 102 operates in the manner described above. Gas is directed by header 115 into the channels which form part of the fluidizing unit. This gas first flows through the unit surface adjacent the compartment discharge outlet 105. Gradually, the area of fluidization increases until gas is flowing through the entire unit surface.

Figure 14 discloses a fluidizing unit 125 in a rectangular compartment 127. This unit is formed with its channels 129 extending from end to end thereof, and it has headers 131 and 132 at its opposite ends. Gas inlet pipes 134 and 135 communicate with the headers 131 and 132, respectively. Compartment 127 has a discharge outlet 139 from an end wall thereof. Gas may be directed into unit 127 through pipe 134 only at the beginning of the discharging operation, in which case, gas is later supplied through inlet pipe 135 as the operation proceeds. However, gas may be supplied through both pipes right from the beginning. The fluidizing operation is as described above.

Figure 15 illustrates a storage compartment in the form of a collapsible bag 150. This bag has an inlet 152 at the top thereof, and a discharge outlet 153 in an end wall near the bottom thereof. The bag is provided with any one of the fluidizing units described above, unit 22 being shown for this purpose. Gas is directed into the unit through an inlet pipe 155 which extends through an end wall of the bag.

Unit 22 operates as described above to fluidize and discharge particle material through the outlet 153 of bag 150. It is preferable to make the unit out of a semi-rigid material in order that, when the bag is collapsed, it and the unit may be rolled up into a comparatively small bundle. A bag of this nature may be used for shipping materials in small particle form, and the bag may be collapsed and folded up for the return trip. A bag of this nature usually has to be located in a bin or compartment or railroad car with walls bearing against the bag walls in order to keep the latter from bulging outwardly too far.

According to the present method, gas is directed through the unit surface into the compartment near the outlet thereof to fluidize the material at said outlet to cause it to flow through the latter. If the unit material is compressible, the gas inlet for the unit should be near the compartment discharge outlet. On the other hand, if the unit material is rigid or semi-rigid, the gas inlet may be remote from the discharge outlet since the

gas will travel along the channels to a point near said outlet, and the particle material on the unit in the compartment will prevent the passage of gas through the unit surface. In either case, when the outlet is first opened, some of the particle material flows out through it under the action of gravity. This allows the gas to flow through a comparatively small area of the unit surface adjacent the discharge outlet to fluidize the particle material in said area, thereby causing it to flow through the outlet. By supplying gas to a small area of the unit at this time excessive pressure requirements are avoided. The flow of material from the area being fluidized causes some material from above the adjacent unit area to flow under gravity into said fluidization area. This lightens the load on said adjacent unit area. Gas is then directed through a gradually enlarging area of the unit surface to increase the area of fluidization of material to cause material to flow from said increasing area through the outlet. This is continued until gas is passing through substantially the entire surface area. Thus, the area of fluidization is gradually increased so that the compartment is emptied without fluidizing the material under full load at any point through the unit. This provides an even flow of material through the compartment outlet and eliminates the possibility of clogging at said outlet.

The fluidizer units described above are preferably used with this method. The gas is first supplied through the distributing network of channels to the cells adjacent the compartment outlet. It is then directed through the channels to a gradually enlarging area of unit cells to increase the area of fluidization of the material.

WHAT I CLAIM IS:—

1. A fluidizing unit for compartments, conduits and the like on which materials in small particle form are moved in a fluid-like state, comprising a body formed at least in part of a material having minute interconnected cells therethrough and opening outwardly from an upper surface thereof over which material in small particle form is to be moved, distributing means spaced inwardly from said upper surface and communicating with said minute cells, and means for directing gas under pressure into said distributing means.

2. A fluidizing unit as claimed in Claim 1 wherein said body is homogeneous and is formed entirely of a material having minute interconnected cells therethrough.

3. A fluidizing unit as claimed in Claim 1 or 2 wherein said distributing means comprising a network of small closely arranged channels extending throughout the unit substantially parallel with said upper surface.

4. A fluidizing unit as claimed in Claim 1 or 2 wherein said distributing network of closely arranged channels is formed in the lower surface of the unit and extends throughout said lower surface substantially parallel with the upper surface.

5. A fluidizing unit as claimed in Claim 1 or 2 including a supporting structure upon which the unit rests and extending substantially throughout the unit, wherein said distributing network of closely arranged channels is formed in the surface of the supporting structure upon which the unit rests and extends substantially parallel with the unit, said channels opening throughout the length thereof outwardly of the supporting structure and communicating with the minute cells.

6. A fluidizing unit as claimed in any of Claims 1 to 3 wherein the material extending from the face surface to the opposite surface of the body and between adjacent channels provides continuous support throughout the unit body.

7. A fluidizing unit as claimed in any of Claims 1 to 6 including means sealing off the surface of the unit body opposite the face surface thereof to prevent gas from escaping through said sealed surface.

8. A fluidizing unit as claimed in any of the preceding claims in which the channels open out from at least one edge of the unit, and the gas directing means is connected to the channels opening out from said edge.

9. A fluidizing unit as claimed in any of the preceding claims in which the upper surface of the unit body is covered by a material of low gas permeability, said material creating a controlled resistance to the flow of gas through the unit body.

10. A fluidizing unit as claimed in any of the preceding claims including a layer of material of low gas permeability inwardly of and extending substantially parallel with the face surface of the unit body, said material creating a controlled resistance to the flow of gas through the body.

11. A fluidizing unit as claimed in any of Claims 1 to 10 in which the body is formed of a porous rigid material.

12. A fluidizing unit as claimed in Claim 1 wherein said body comprises a first layer of material having minute interconnected cells therethrough and opening outwardly from an upper surface thereof over which material in small particle form is to be moved and a second layer of material beneath and against the first layer.

13. A fluidizing unit as claimed in Claim 12 wherein said distributing means comprises a network of small closely arranged channels extending throughout the second layer substantially parallel with said upper surface.

14. A fluidizing unit as claimed in Claim 12 or 13 in which the material of the second layer is rigid enough to keep the channels open when there is a load of particle material on said upper surface.

15. A fluidizing unit as claimed in Claim 12 or 13 in which the second layer is formed of a semi-rigid material capable of keeping the channels open when there is a load of particle material in said upper surface.

16. A fluidizing unit as claimed in Claim 12 or 13 in which the two layers are formed of the same material which is semi-rigid and capable of keeping the channels open when there is a load of particle material on said upper surface.

17. A fluidizing unit as claimed in any of Claims 12 to 16 wherein the material extending from the upper surface to the opposite surface of the body and between adjacent channels provides continuous support throughout the unit body.

18. A fluidizing unit as claimed in any of Claims 1 to 17 wherein said body is such that the upper surface remains substantially even under conditions varying from no load to heavy load and when gas under pressure is being directed through the channels and thence through the minute cells to and through said upper surface, and said cells being such as to distribute the gas evenly throughout said upper surface to fluidize any particle material at said surface.

19. A fluidizing unit as claimed in any of the preceding claims wherein said body diminishes in width from one edge to the other, the cross-sectional area of said distributing network also diminishing as the body width diminishes.

20. In a compartment for materials in small particle form and having confining walls, a bottom and a discharge outlet near the bottom thereof, a fluidizing unit as claimed in any of the preceding claims.

21. A compartment as claimed in Claim 20 wherein said fluidizing unit is mounted on the bottom of the compartment.

22. A compartment as claimed in Claim 21 having means securing the edges of said fluidizing unit to the compartment walls at the bottom of the latter.

23. A compartment as claimed in Claim 20 wherein said fluidizing unit is mounted on a confining wall of said compartment.

24. In a conduit for materials in small particle form and having opposed side walls and a bottom, a fluidizing unit as claimed in any of Claims 1 to 19, said unit extending from part way up one side wall across the bottom and part way up the other side wall of the conduit.

25. A method of unloading material in small particle form from a compartment having a floor, and an outlet near said floor, which comprises providing a fluidizing unit on the floor which unit is constructed in accordance with any of Claims 1—19, directing a gas through the surface of the unit into the compartment to fluidize the material near the outlet to cause it to flow through the latter, said flow of material from the area being fluidized causing some material from above the adjacent unit area to flow into said fluidization area, and directing gas through a gradually enlarging area of the unit surface to increase the area of fluidization of the material to cause material to flow from said increasing area through the outlet until gas is passing through substantially the entire area, thereby emptying the compartment without having fluidized the material under full load.

26. A fluidizing unit for compartments, conduits and the like on which materials in small particle form are moved in a fluid-like state, constructed, arranged and adapted to operate substantially as described herein with reference to the accompanying drawings.

27. A method of unloading material in small particle form substantially as described herein with reference to the accompanying drawings.

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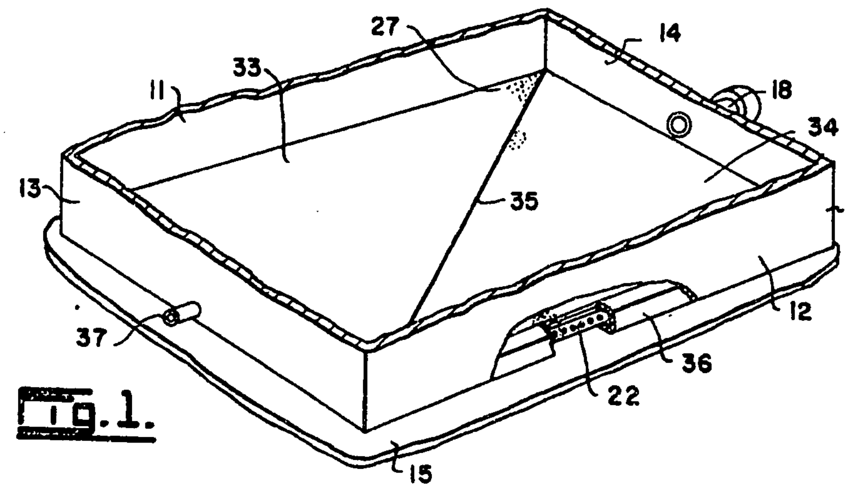


Fig. 1.

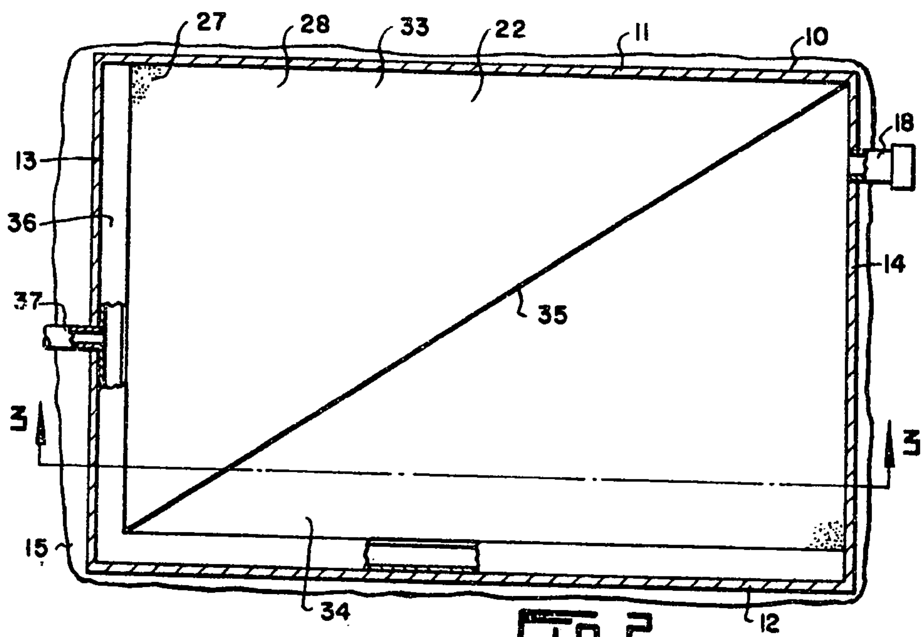


Fig. 2.

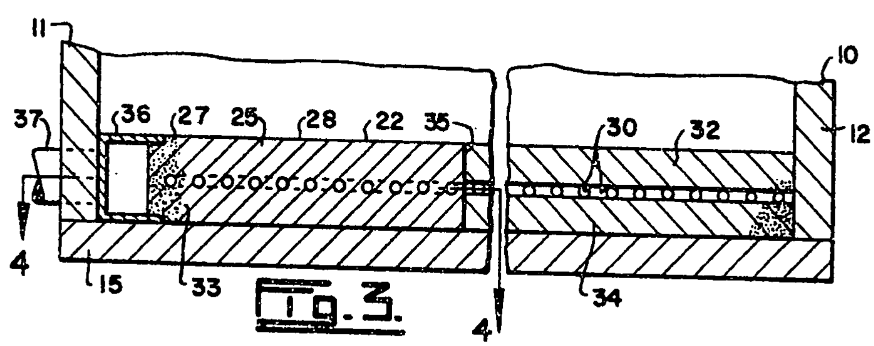
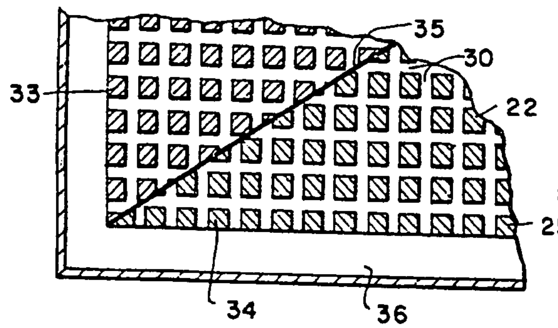


Fig. 3.



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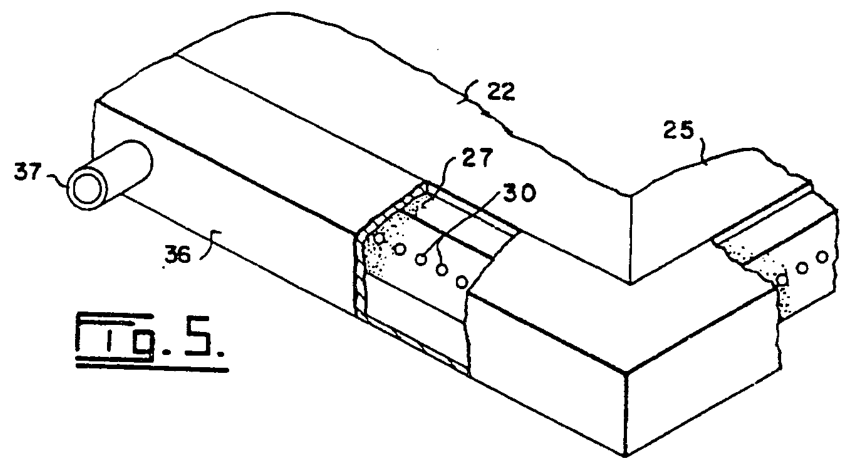

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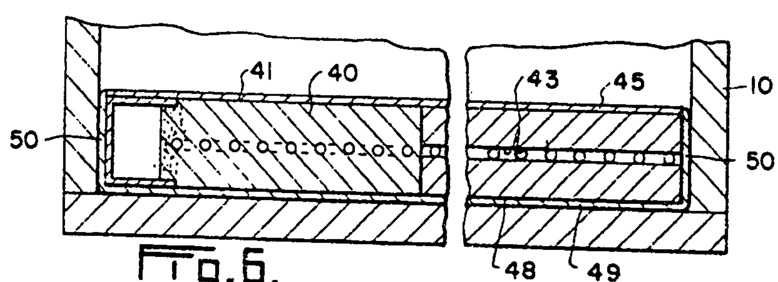

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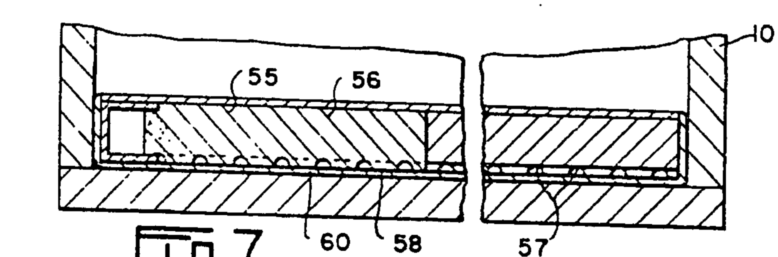

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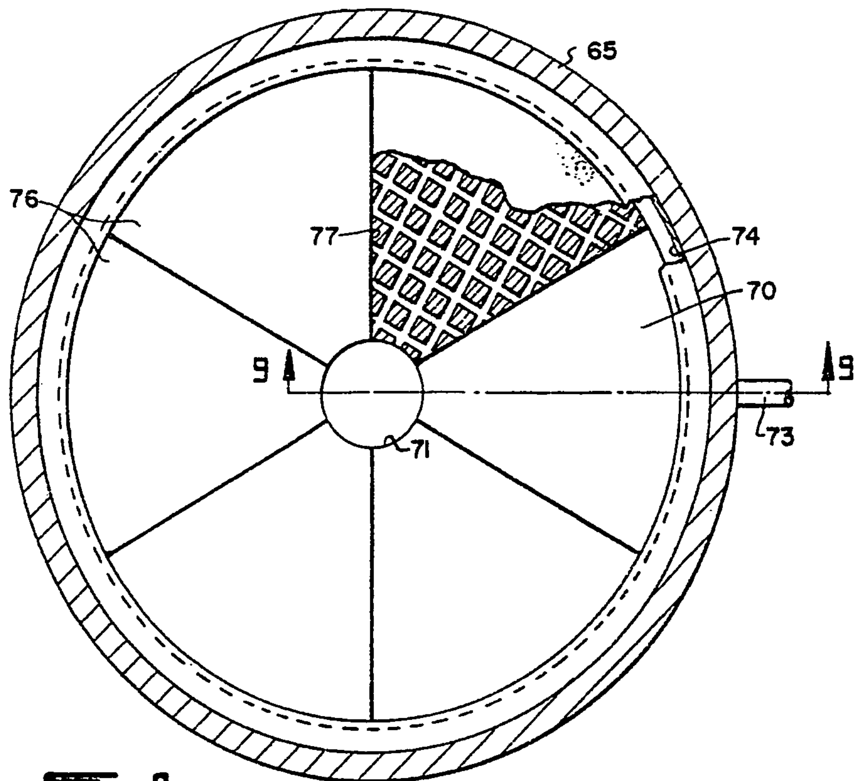

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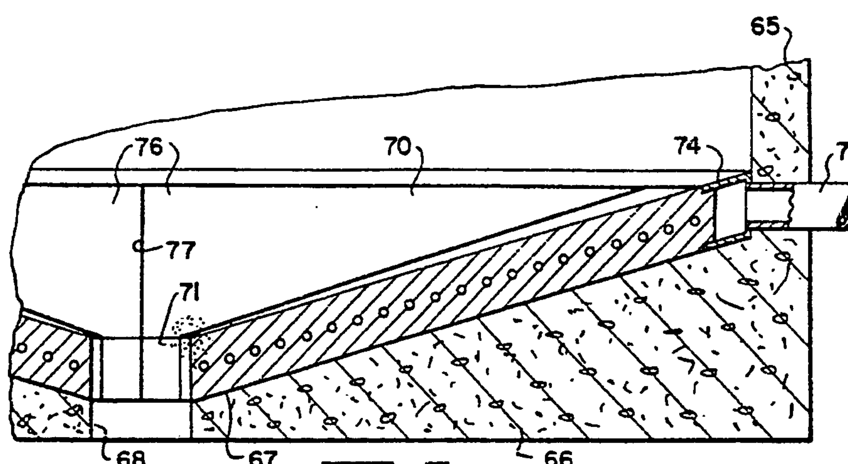

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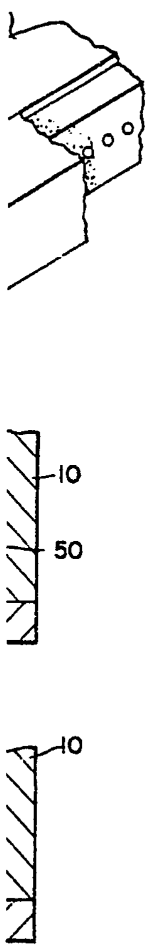

885,525 COMPLETE SPECIFICATION
5 SHEETS
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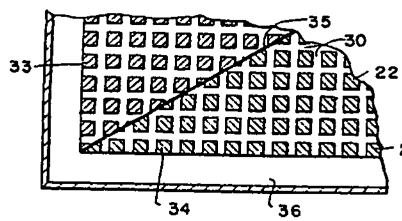
SHEETS 2 & 3



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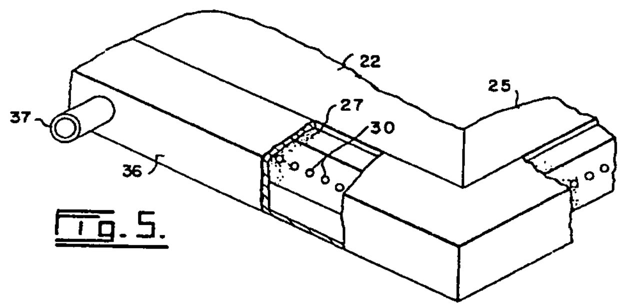

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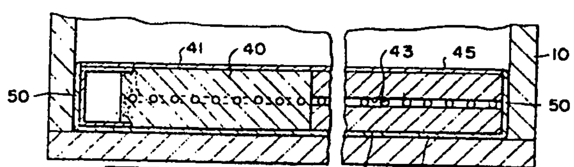

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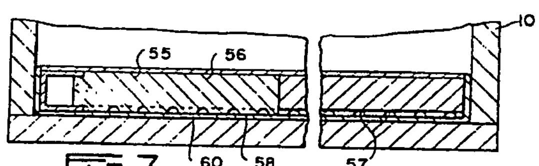

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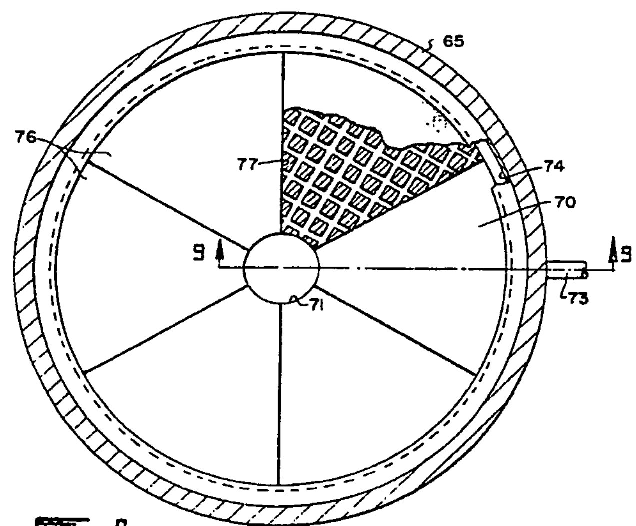

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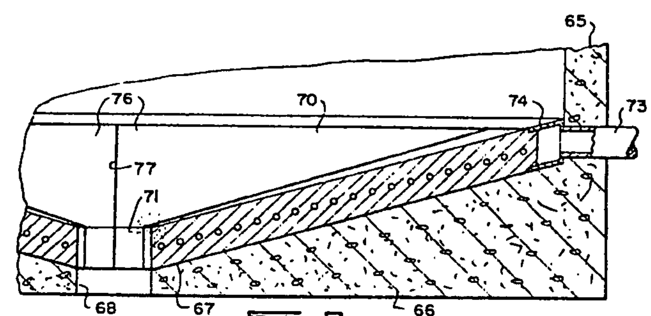

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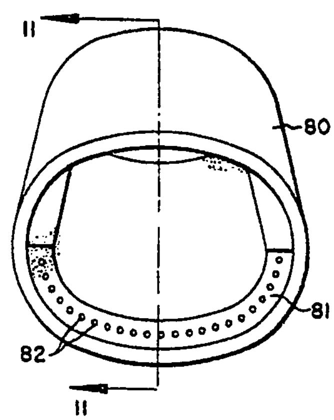

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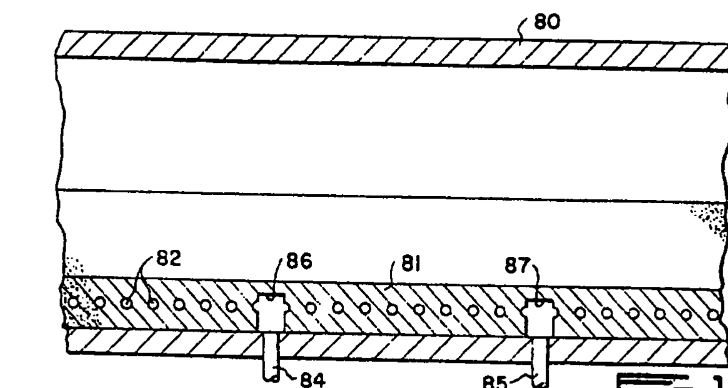

Fig.11.

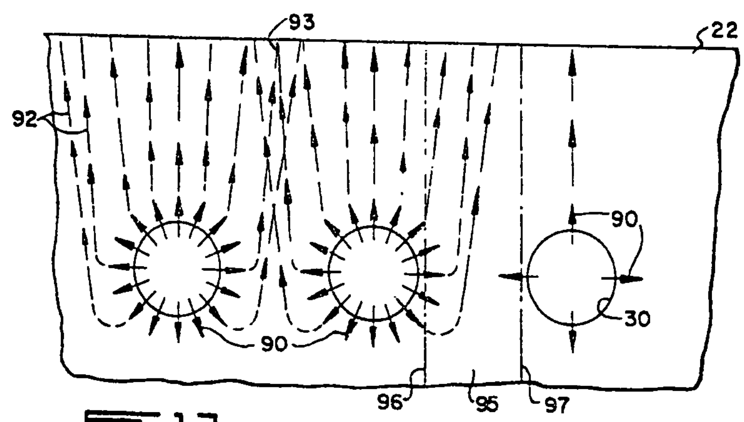

Fig.12.

885,525 COMPLETE SPECIFICATION
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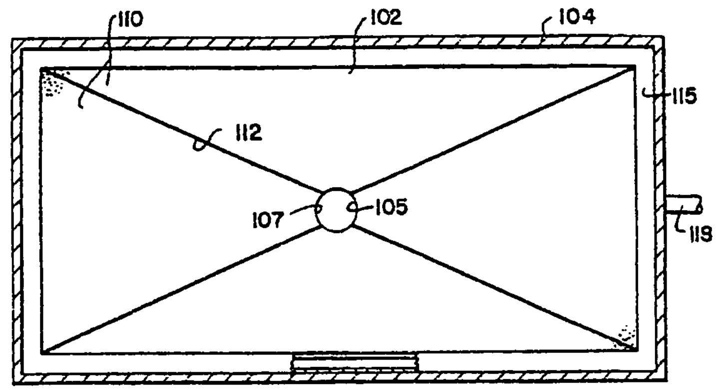
SHEETS 4 & 5



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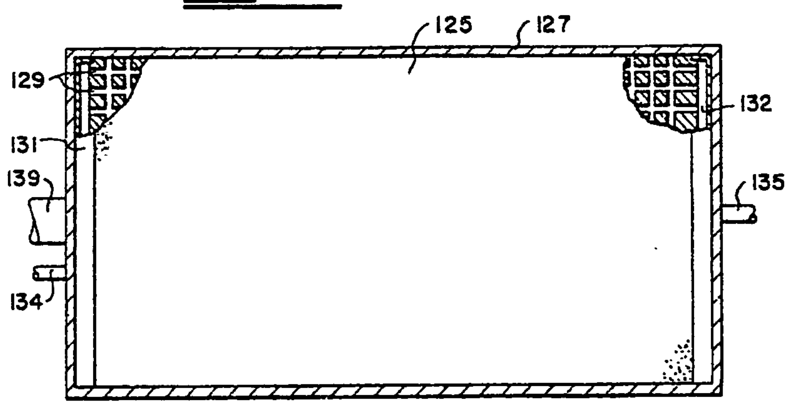

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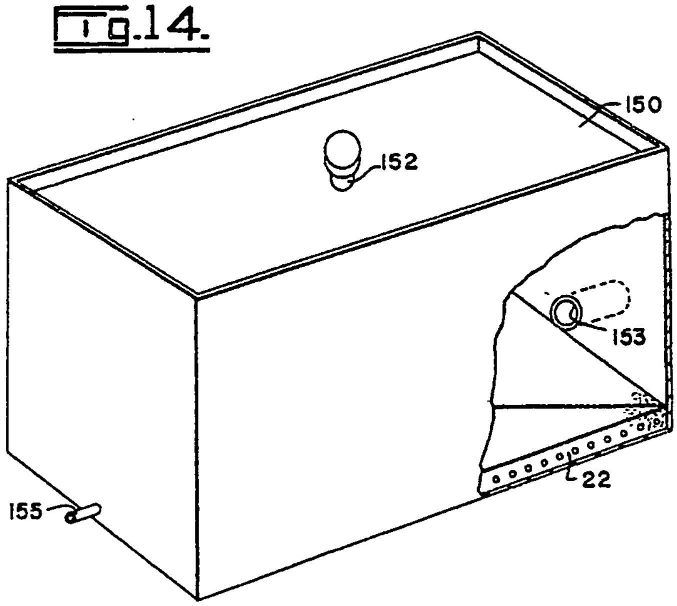

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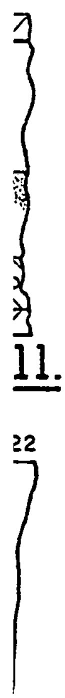

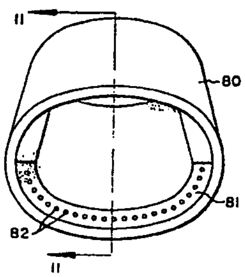

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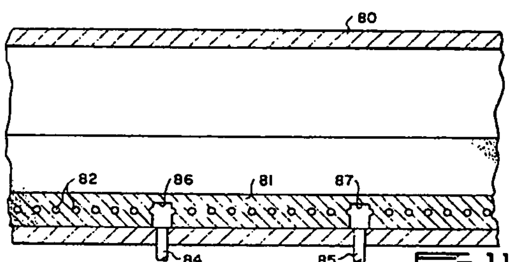

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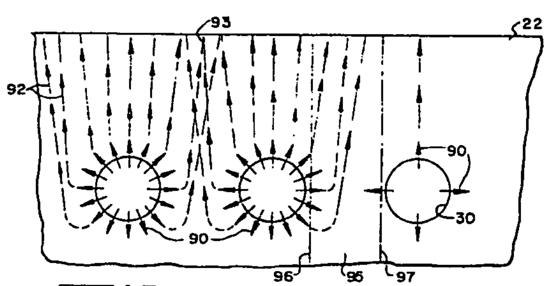

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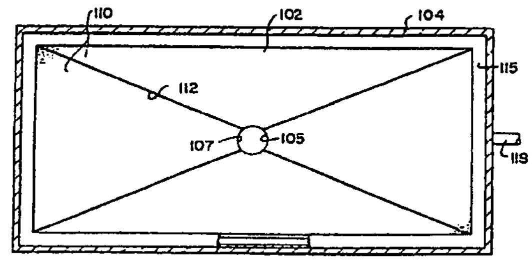

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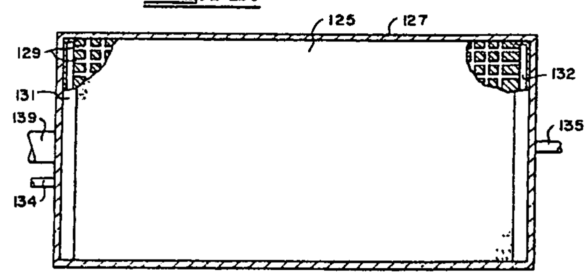

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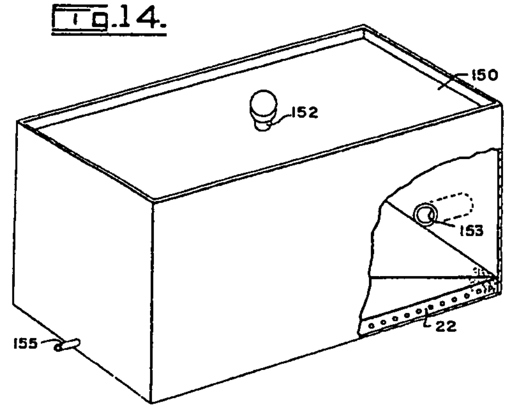

Fig.15.